MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER BUREAU
LANSING OPERATIONS DIVISION
DRINKING WATER & ENVIRONMENTAL HEALTH SECTION
WELL CONSTRUCTION UNIT
ABANDONED WELL MANAGEMENT PROGRAM

# *Abandoned Water Well Plugging Regulations*

In Michigan, the plugging of water wells is regulated under the authority of Part 127, Act 368 PA 1978. The Act authorizes promulgation of rules contained within the Michigan Water Well Construction and Pump Installation Code. The following rules from the code apply to abandoned wells.

**R 325.1601 Definitions; A.**

Rule 101. (1) "Abandoned water well" means any of the following:

(a) A well which has its use permanently discontinued.

(b) A well which is in such disrepair that its continued use for the purpose of obtaining groundwater is impractical.

(c) A well which has been left uncompleted.

(d) A well which is a threat to groundwater resources.

(e) A well which is or may be a health or safety hazard.

**R 325.1605 Definitions; R to T.**

Rule 105. (6) "Temporarily abandoned well" means a well that is not in use, but is intended by the owner to be used as a source of groundwater.

**R 325.1606 Definitions; V to Y**

Rule 106. (4) "Well drilling" means any of the following:

(a) Constructing, reconstructing or repairing a well.

(b) Operating a well drilling machine.

(c) Installing or removing casing or a well screen.

(d) Well grouting.

(e) Well development.

(f) Well rehabilitation.

(g) Hydrofracturing.

(h) Chemical treatment of a well.

(i) Plugging abandoned wells.

**R 325.1662 Abandoned wells and dry holes; persons responsible for plugging; removal of debris and obstructions; wells taken out of service when municipal water is installed.**

Rule 162. (1) An abandoned well or dry hole shall be plugged by a well drilling contractor who is registered pursuant to the provisions of the act or by the well owner. An abandoned well that is located on property which has a well that serves the public or a residence other than the well owner's residence, shall be plugged by a registered well drilling contractor.

(2) A pump, a drop pipe, a packer, other equipment, debris, or obstructions shall be removed from the well, if possible, before plugging.

(3) A well that is abandoned when municipal water is installed shall be plugged pursuant to the provisions of these rules.

**R 325.1663 Abandoned wells and dry holes; plugging method.**

Rule 163. (1) An abandoned well or dry hole shall be plugged as follows:

(a) A well or dry hole that terminates in overburden shall be plugged by filling with any of the following materials:

(i) Neat cement.

(ii) Concrete grout.

(iii) Bentonite chips.

(iv) Bentonite pellets.

(v) Bentonite grout.

(b) A section of a well or dry hole that is in bedrock shall be plugged by filling with neat cement or concrete grout from the bottom of the well or dry hole to not less than 20 feet above the top of the bedrock or to the ground surface. The section of the well from 20 feet above the bedrock to the ground surface shall be plugged in accordance with the provisions of subdivision (a) of this subrule.

(2) Gravel, sand, stone aggregate, or other materials that are acceptable to the department may be used for plugging that portion of a well that penetrates lost circulation zones, such as gravel or cavernous, creviced, or fractured bedrock.

(3) The flow from an abandoned flowing well shall be stopped by plugging the well with neat cement or concrete grout.

(4) Abandoned wells that discharge subterranean gases shall be plugged with neat cement or concrete grout.

**R 325.1664 Abandonment of wells; plugging materials.**

Rule 164. Abandoned well or dry hole plugging materials shall be placed as follows:

(a) Bentonite chips or bentonite pellets shall be poured slowly into the top of the well or dry hole to prevent bridging in the casing or borehole. Fine bentonite particles that accumulate in the shipping container shall not be used. The plugging operation shall continue until the bentonite chips or bentonite pellets appear at the ground surface. Upon completion of the plugging operation, water shall be placed into the casing or borehole to promote expansion of the bentonite above the static water level.

(b) Neat cement, concrete grout, or bentonite grout shall be placed through a tremie pipe from the bottom of the well or dry hole to the ground surface.

(c) Other materials and methods may be used if the materials and methods proposed to be used will plug the abandoned well or dry hole to prevent them from acting as a channel for contamination or the escape of subterranean gases and if prior approval is given by a health officer.

**R 325.1665 Plugging of dug wells and crock wells.**

Rule 165. A large diameter dug well or crock well shall be plugged pursuant to the provisions of R 325.1663 and R 325.1664 or may be plugged as follows:

(a) A layer of bentonite chips or bentonite pellets that is not less than 6 inches thick shall be placed at the bottom of the well. The remainder of the well shall be plugged by placing clean soil backfill in layers that are not more than 10 feet thick, with a layer of bentonite chips or bentonite pellets that is not less than 6 inches thick placed on top of each clean soil backfill layer. Dry granular bentonite may be used in place of, or in combination with, bentonite chips or bentonite pellets, and neat cement or concrete grout may be poured if the well has been dewatered before plugging.

(b) The uppermost section of concrete crock or tile or the upper 3 feet of stone, brick, or other curbing material that supports the well bore shall be removed. Before backfilling the well up to the ground surface, a layer of bentonite chips or bentonite pellets that is not less than 6 inches thick shall be placed.

**R 325.1667 Plugging wells drilled by person other than property owner or registered well drilling contractor.**

Rule 167. A well that was drilled by a person other than the property owner or by a person other than a well drilling contractor who is registered pursuant to the provisions of the act shall be abandoned and plugged pursuant to the provisions of these rules.

**R 325.1668 Order to plug abandoned well or dry hole.**

Rule 168. The department or a health officer may order a well owner or a registered well drilling contractor to plug an abandoned well or a dry hole.

**R 325.1669 Owner and contractor responsibility for plugging abandoned wells.**

Rule 169. (1) A well owner shall be responsible for the plugging of an abandoned well**,** except as provided in a written contract between the owner and a registered well drilling contractor.

(2) If a health officer or the department determines that a registered well drilling contractor has improperly located or constructed a well, the well drilling contractor shall be responsible for plugging the well.

**R 325.1670 Temporarily abandoned wells.**

Rule 170. (1) A temporarily abandoned well shall be in compliance with the minimum construction and isolation distance requirements of these rules.

(2) A temporarily abandoned well shall be disconnected from any water distribution piping and shall have the top of the casing securely capped to prevent the entrance of surface water or foreign materials into the well and to prevent access to the well.

**R 325.1675 Well records.**

Rule 175. (3) Within 60 days after plugging an abandoned well or dry hole, the person who performed the plugging operation shall provide the department or local health department with 2 copies of a report that sets forth all of the following information:

(a) The well owner's name.
(b) The location of the well.
(c) The well depth.
(d) The well diameter.
(e) The plugging procedure.
(f) The plugging material.
(g) The amount of plugging material used.

Standard forms for the report shall be provided by the department. When an abandoned well is plugged where a replacement well will be or has been constructed, the plugging information may be recorded on the well log that is submitted for the replacement well. Information on several abandoned wells or dry holes within a single parcel may be submitted on a single well log form if the geologic materials and plugging methods are similar.

(4) A well log shall be signed by a registered well drilling contractor.

## Abandoned Well Plugging Record (Form EQP 2044)

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# PLUGGING ABANDONED WELLS

## RATIONALE

When a well is abandoned for any reason, it should be “plugged” rather than “capped.” This would include "dry holes," wells that are being replaced by a new well, wells that no longer produce water, wells producing water of unsuitable quality, or any other case where a well is no longer being used. The term "plugged" means to be filled up with an impervious material. The reason for doing so is to prevent contamination of the fresh water aquifer by foreign material from the surface or by water from other strata which may be of lower quality.

## RESPONSIBILITY

The well owner is ultimately responsible to assure that any abandoned well on his/her property is properly plugged. Local health departments issuing replacement well permits should include a stipulation on the permit indicating the requirement to plug the existing well unless the well is going to be immediately placed back into working condition. When conducting the final inspection for the replacement well, a field inspection shall also be conducted to assure that the old well has been either properly plugged or repaired and made operational. The well driller is responsible for plugging "dry holes" and other drill holes where a permanent well is not installed.

## PLUGGING MATERIALS

The common materials that are now available for plugging abandoned wells are: bentonite grouts/slurries (either powdered or granular), coarse grade bentonite, neat cement, and concrete grout. The most effective abandoned well plugging material is neat cement grout.

At this time, coated bentonite pellets are not recommended for plugging abandoned wells due to the detection of acetone in some pellet coatings.

### Bentonite Grouts/Slurries:

This category of well plugging materials includes powdered and granular bentonite slurries. They all consist of bentonite solids placed in water, a mixture that remains pumpable for a short period of time. The plugging of a well is generally done in one continuous operation with placement from the bottom of the well upward by pumping the material through a tremie pipe. Upon placement, the bentonite particles in the slurry absorb water and swell in place to form a pliable seal of low permeability. Their use in plugging wells in Michigan is restricted generally to drift wells. Mixing directions and yield of product will vary greatly between the different bentonite types and manufacturers. Some products may require considerable caution and/or experience in their use to consistently achieve acceptable results.

### Coarse Grade/Pelletized Bentonite:

These plugging materials consist of bentonite in crushed, chipped, granular, or compressed states to achieve particle sizes of 1/4 to 3/4 inch. They are intended for use and placement by pouring through the water column and cannot be pumped. Placement should be performed slowly and accompanied by tamping or measurement to check the level of accumulated bentonite and insure that 'bridging" has not occurred. The bentonite must be prescreened before placement to remove all fine powder that accumulates in the shipping containers (bags). Screening is intended to eliminate the fines that will immediately hydrate upon coming in contact with water and cause “bridging” of the bentonite inside the casing. Bentonite chips shall be poured slowly, with rates not to exceed 50 lbs in 3 - 5 minutes. Slower rates of

placement are required in smaller diameter wells. Once in place, the bentonite chips swell to form a high solids, low permeability plug.

**Neat Cement/Concrete Grouts:**
Neat Cement consists of 1 bag (94 lbs.) of Portland cement mixed with not more than 6 gallons of water. Neat cement grout is placed from the bottom of the well upward in one continuous operation until the well is filled. This is generally done by pumping the grout through a tremie pipe extended to the bottom of the well. Concrete grout consists of 1 bag of cement, an equal volume of sand, and not more than 6 gallons of water. Concrete grout is difficult to pump using conventional grout pumping equipment. Placement is largely restricted lo the dry portion of an abandoned well or dry hole.

**RECOMMENDED PROCEDURES**
Abandoned wells shall be checked for obstructions before they are plugged in order to verify that anything that may interfere with the plugging operations has been removed. Drop pipes, check valves, pumps, drawdown seals, and any accumulated debris, must be removed from the well to enable the well drilling contractor to properly plug the well. In cases where the drilling contractor cannot eliminate an obstruction from an abandoned well, the driller shall advise the local health department and shall indicate the obstruction removal efforts he/she performed under "comments" on the Abandoned Well Plugging Record. Obstruction removal tools are termed "fishing tools" by the well drilling industry. They are specialized in design, require drilling rigs or pump hoist trucks to use, and take experienced workmen to operate. Obstruction removal activities should be conducted by registered well drilling contractors or specialty firms. Homeowners are ill equipped to attempt obstruction removal activities.

The depth of the abandoned well shall be measured to allow the well drilling contractor to estimate the total volume of plugging material necessary to completely fill the abandoned well casing and/or borehole. Casing size and depth are used to calculate the required volume of plugging material. The tables at the end of this document are useful in estimating volumes of plugging material necessary for typical well plugging jobs.

**Wells Terminated in Unconsolidated Formations (Drift wells):**
Screens in small diameter "point" or driven wells and in typical 2 inch to 6 inch drift wells are generally not removed when the well is abandoned. In situations where the casing and screen are to be removed, the screen should be removed first, then as the casing is being removed, the hole should be kept full of the grouting material, adding more grout from time to time during the process. A few days after the casing is removed, a visit should be made to the site to determine if settling has occurred. If settling of less than 20 feet has occurred, the unfilled portion of the borehole may be refilled with an approved grout by pouring from the surface.

**Wells Terminated in Rock Formations:**
Where an abandoned well is determined to be terminated in rock, the well must be plugged with neat cement or concrete grout. Geologic information documenting the presence of bedrock or drift formations are typically identified on the original well drilling record for the well being abandoned. Alternatively, where no record exists for the abandoned well, records of other nearby wells may be used to establish typical geologic conditions for the area, including the presence and depth of bedrock.

When calculating the amount of plugging material necessary to plug a rock well, the normal procedure is to determine the casing and borehole volume, then add 20 percent for material loss into the rock formation.

In some rock formations, fractures or porous conditions may occur. These conditions are termed “lost circulation zones” and must be addressed in order for the abandoned well to be effectively plugged. Fractured intervals within a rock bore hole may be filled with aggregate mixed with neat cement or a commercial plugging additive. The remainder of the well shall be plugged using standard neat cement placement procedures. Where porous conditions are encountered, a commercial plugging additive like cellophane flakes, ground walnut shells, or medium ground bentonite granules, etc. added to the neat cement or concrete grout typically will be employed to reduce loss to the formation and accomplish plugging the well.

When using a neat cement or concrete grout slurry for plugging rock wells, the plugging material shall be pumped from the bottom of the well to the surface using a tremie pipe. If simultaneously placing aggregate to fill fractures, the tremie pipe must be raised as the plugging material is pumped to keep it from becoming stuck in the well by the aggregate.

**Flowing Wells:**
In most cases, neat cement grout pumped directly into the well will stop the flow. However, the plugging of a flowing well can present unusual difficulties and hidden problems which must be handled properly. An inaccurate assessment of the situation can result in water breaking out around the casing or channeling of the water through porous drift formations with subsequent discharge to the surface either at the well or in the vicinity of the well.

It is important to know the depth of the strata from which the flow originated, the discharge rate of the well, and the hydrostatic head characteristics of the well. It is also important to know how (or if) the well was grouted when it was installed. The majority of problems associated with plugging flowing wells result from improper flow control, not stopping the flow before starting the plugging operation, or the grout column weight being inadequate to “hold down” the flow.

Due to their upward, continuously discharging flow, flowing wells often erode void spaces in the formation just below and along the well casing. Because the voids must be filled before the well casing can be plugged effectively, such circumstances frequently require many more times the calculated grout volume than you would expect when calculations are based upon the well casing diameter and casing length alone.

Situations are encountered where the artesian pressure of the formation exceeds the weight of the grout slurry columns. These circumstances require a means of increasing the weight of the grout slurry or provisions for additional flow control. A reliable approach involves (1) stopping or controlling the discharge, and (2) determining the hydrostatic pressure head.

When the head pressure is less than 10 psi, the first option is usually to install a casing seal with a discharge valve on the well head. Once this piping is in place, neat cement is pumped into the well against the pressure head. After delivering the calculated volume of plugging material, the valve is closed and the slurry is allowed to set. The casing seal and closed valve prevent the grout from washing back out of the abandoned “flowing” well.

Where higher head pressures exist (greater than 10 psi), stopping the flow by installing a casing riser may be more effective. Casing risers may extend 20-25 feet above grade but become less practical at greater lengths. When using a casing riser, the concept is to have the discharge water from the well retained inside a vertical well casing extension that is attached to the existing well casing. The water will rise up inside the casing extension to the point of the well’s natural static level, which may be many feet above grade. Once this occurs, the “flow” naturally stops. A tremie pipe can be placed down the casing riser to the bottom of the well.

The neat cement grout can be pumped into the well without risking it being expelled because there is no longer any “flowing” discharge.

In some instances, artesian pressures are so great that containing the flow by extending the casing or drive pipe is not possible. The drive pipe can be fitted with valves and connections to allow pumping of neat cement directly into the well and annular space. In these extreme cases, large volumes of plugging material may have to be placed under high pressure. The most reliable means of completing a plugging job of this nature is by the well drilling contractor subcontracting with an oil field cementing firm.

The Michigan Department of Environmental Quality, Groundwater Section may be contacted for more information concerning this alternative. More detailed information on plugging flowing wells can be found in the DEQ’s Flowing Well Handbook.

Some older well casings may be deteriorated to the point that placing grout through them under pressure is impractical. There may also be washouts along the outside of the casing where holes in the casing are present and the flow has been discharging. In these cases, an outer drive pipe and the use of a plugging design utilizing a tremie pipe will usually be necessary.

**REPORTS**

An Abandoned Well Plugging Record must be filed with the DEQ and local health department. The report must include the type and amount of plugging material used and the method of placement of the plugging material. A Water Well and Pump Record form may also be used for this purpose. Abandoned well plugging records may also be filed electronically using the DEQ Wellogic program. For more information on using Wellogic, please email the Wellogic Staff at deq-dwr-wellogic@michigan.gov.

# NEAT CEMENT GROUT SLURRY PROPERTIES
**(For Type I Portland Cement - 94 lbs./bag)**

| Water Ratio | Minimum Density | Slurry Volume | |
|---|---|---|---|
| (Gal./bag) | (Lbs./gal.) | (Cu. ft./bag) | (Gal./bag) |
| 5.2 | 15.6 | 1.18 | 8.8 |
| 6.0 | 15.0 | 1.28 | 9.6 |

# HOLE VOLUME
**(For Plugging Abandoned Wells and Boreholes)**

| Well Diameter | Volume per ft. of depth | | Feet of well plugged | |
|---|---|---|---|---|
| | | | Neat Cement | Bentonite Chips* |
| (inches) | (cubic [illegible]) | (gallons [illegible]) | (94 lb. [illegible]) | (50 lb. bag) |
| 1 1/4 | 0.01 | 0.07 | 118.0 | 70.0 |
| 2 | 0.02 | 0.17 | 51.3 | 31.3 |
| 3 | 0.05 | 0.38 | 23.1 | 14.3 |
| 4 | 0.09 | 0.66 | 13.4 | 7.9 |
| 5 | 0.14 | 1.00 | 8.5 | 5.1 |
| 6 | 0.20 | 1.50 | 5.9 | 3.5 |
| 8 | 0.35 | 2.60 | 3.4 | 2.0 |
| 12 | 0.80 | 6.00 | 2.1 | 0.9 |
| 14 | 1.07 | 8.00 | 1.1 | 0.6 |
| 16 | 1.40 | 10.44 | 0.8 | 0.5 |
| 18 | 1.77 | 13.20 | 0.7 | 0.4 |
| 24 | 3.14 | 23.50 | 0.4 | 0.2 |
| 36 | 7.07 | 53.00 | 0.2 | 0.1 |

Bentonite chips, and other bentonite grouts are not permitted for plugging the bedrock portion of a borehole.

# VOLUME OF ANNULAR SPACE BETWEEN CASING AND BOREHOLE

| Casing Size | Borehole Size | Volume Per foot of well depth | |
|---|---|---|---|
| (inches) | (inches) | (cubic feet) | (gallons) |
| 2 | 4 | 0.06 | 0.42 |
| 2 | 5 | 0.10 | 0.79 |
| 2 | 6 | 0.17 | 1.24 |
| 4 | 6 | 0.09 | 0.64 |
| 4 | 7 | 0.16 | 1.17 |
| 4 | 8 | 0.24 | 1.79 |
| 5 | 7 | 0.10 | 0.77 |
| 5 | 8 | 0.18 | 1.38 |
| 5 | 9 | 0.28 | 2.07 |
| 6 | 8 | 0.11 | 0.82 |
| 6 | 9 | 0.20 | 1.51 |
| 6 | 10 | 0.31 | 2.29 |
| 8 | 12 | 0.38 | 2.84 |
| 8 | 16 | 1.00 | 7.44 |
| 12 | 16 | 0.51 | 3.81 |
| 12 | 24 | 2.25 | 16.86 |
| 16 | 20 | 0.79 | 5.87 |
| 16 | 32 | 4.19 | 31.33 |

# PLUGGING ABANDONED WELLS
# - FIVE STEPS -

**1. Locate the Abandoned Well**

- ✓ Look for physical evidence such as casing, well pits, cement slabs, windmills.
- ✓ Talk to previous owners, neighbors, contractors, inspectors.
- ✓ Search for records such as permits, well logs, bills, receipts, photographs.
- ✓ Use equipment and tools such as a metal detector, a detectable tape, or a magnetometer.

**2. Remove Obstructions**

- ✓ Can be very difficult for homeowners to do because obstruction become encrusted and stuck down in the well.
- ✓ Registered well drilling contractors have the knowledge and specialized equipment to perform this work efficiently.
- ✓ May require a well drilling rig or pump hoist.

**3. Select and Place Plugging Materials**

- ✓ Different types of wells (rock, drift, flowing, etc.) require different types of plugging materials.
- ✓ The well must be measured to calculate volume of plugging material.
- ✓ Specific methods and materials are mandated in the Well Construction Code.

**4. Restore the Site**

- ✓ Cutting off the casing is currently not a Well Construction Code requirement.
- ✓ If a casing is to be cut off, 4 feet below grade is an appropriate cut-off depth for most standard sites.
- ✓ All materials that were extracted from the well (drop pipe, pumps, debris, etc.) should be properly disposed of.
- ✓ The area around the excavation shall be graded so as to prevent water from accumulating around the former well site, and seeded to discourage erosion.

**5. Complete an Abandoned Well Plugging Record**

- ✓ Plugging records are required to be submitted to the DEQ through the Wellogic electronic data system or submitted to the local health department in hard copy form, within 60 days from the completion date of the plugging work.
- ✓ Plugging Records are to be completed and signed by either the registered water well drilling contractor or the well owner, depending upon who plugged the well.